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Bacterial contribution to the degradation/preservation of organic matter: comparing amorphous organic matter in Upper Jurassic laminites with a recent bacterial analogue

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Hydrogen-rich amorphous organic matter (AOM) is a major component of petroleum source rocks. It is commonly observed in natural and blue light microscopy after extraction from rocks through palynological preparation. Other methods can be used, such as scanning electron microscopy (SEM), transmission electron microscopy (TEM) and organic geochemistry (pyrolysis, extracts of soluble kerogen fraction). However, the representativity of geochemical analyses on extracts to identify the real constituents of organic matter is debatable. AOM in Upper Jurassic organic-rich laminites at Orbagnoux (Jura, France) has been thoroughly studied with different microscopical techniques down to the nanoscale. These laminites were deposited in a lagoon sheltered from the open carbonate platform by a barrier reef (Bernier, 1984). They are interpreted as a fossil analog of recent "kopara" deposits in Pacific atolls (Tribovillard et al., 2000). So far, all petrographic observation of the AOM at Orbagnoux highlight that vulcanization of lipids is the dominant preservation pathway leading to the amorphization at the nanoscale of the preserved organic matter (Mongenot et al., 1997). AOM was palynologically extracted from the laminites before being studied with the following microscopical tools: SEM which illustrates the AOM surface down to micrometer-scale; Atomic Force Microscopy (AFM) which permits the observation of AOM surface with a resolution down to 10 nanometers; TEM on ultrathin section which reveal the texture of AOM constituents with a resolution between one micron

and 10 nanometers. In order to evaluate the bacterial contribution in this AOM the observed structures were subsequently compared with a recent cyanobacterial analogue (biofilm) of Orbagnoux laminites using the same techniques. On the contrary to previous observations, the microscopic data show that fossil AOM is structured at nanometer-scale. Comparisons with the recent bacterial analogue indicate that this nanostructuration is partially of bacterial origin. The bacterial presence is microscopically well identified by filaments and coccoid. The ubiquitous presence of nanoballs may be another clue for a biological origin. Moreover, a network mimicking exopolymeric substances (EPS) of the recent analogue characterizes the AOM structure. These results show that preservation mechanisms of organic matter need to be revisited.

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